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RECTILINEAR POTENTIOMETER

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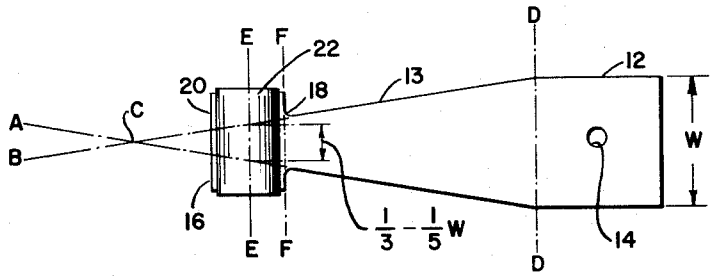


FIG. 1

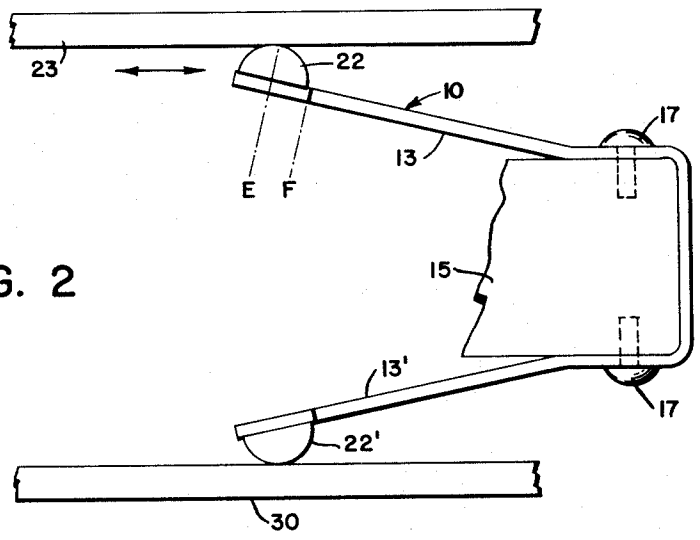


FIG. 2

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RECTILINEAR POTENTIOMETER

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The present invention relates to rectilinear potentiometers employing an improved brush arm and metal wiper contact assembly wherein the brush has a high degree of flexibility and yet provides a secure, non-rupturable base for mounting the said wiper contact. More particularly, the present invention relates to precision rectilinear potentiometers employing miniaturized brush arm structures.

This application is a continuation-in-part of my copending application entitled, "Potentiometer Brush Arm," Serial No. 724,651, now abandoned.

In general, a potentiometer comprises a resistance element which may be of metal or conductive plastic, fixed terminals connected to the ends of the resistance element, and in some instances, additional fixed terminals to intermediate portions of the element so as to provide a fixed voltage ratio between an input voltage to the potentiometer and a given pair of output terminals. A movable wiper contact is arranged to traverse the resistance element and terminal means are associated therewith to provide a variable output voltage corresponding to the position of the wiper contact on the resistance element. In order to provide a constant and minimal contact resistance between the wiper contact and the resistance element, the wiper contact is tensioned against the resistance element by means of a spring member. The pressure exerted by the spring member is governed by the permissible frictional resistance permitted by the particular application and the minimum pressure required in order to provide uninterrupted contact under conditions of operation.

The growing fields of instrumentation, automation, and long range military missiles are typical of those employing precision potentiometers which are required to meet highly critical specialized specifications. Thus, precision potentiometers adapted to be used in very high speed computing mechanisms or in guided missiles may be subject to impact, vibration and other stresses not anticipated in the field of manufacture and design of potentiometer devices even in the recent past. Thus, where a potentiometer is placed in a guided missile, for example, the brush arm must have a minimum contact resistance while riding on the resistance element or the conductor strip, commonly called the "take-off," and yet have very high structural strength.

In practice, the only contact materials combining hardness and resistance to wear with high electrical conductivity have been metal pellets. In general, such pellets are formed of precious metal alloys chosen for maximum hardness and resistance to oxidation and sulfidation. A complex and difficult problem in construction then arises, namely, of positioning a pellet of this type on a small, flexible brush arm. Thus, the brush arm is required to maintain maximum flexibility and resistance to fatigue while offering a sturdy support for such a pellet.

It has been noted that a point of failure in guided missiles applications, for example, has been the rupture of the pellet from the retaining brush arm under the stress

of the very high thrusts and velocity encountered. The conventional soldered bond between spring and contact, which has been adequate for the general application of potentiometers has thus been seen to fail in practice for this type of critical application.

In general, the requirements for miniaturization of a device of this type require that the length of the brush arm cantilevered from a support member be not more than about one-half inch. The brush arm at the support point must be broad enough to contain a rivet bolt or equivalent.

Specifications often call for a very precise correspondence between the physical position of the shaft and a corresponding electrical output. Typically this necessitates accurate placement of the contact sometimes within 0.005" of an optimum position. Often in practice all parts can be fitted together only in one location, and accumulated tolerances of parts such as shaft, brush block, springs, element, case and washers will create a greater uncertainty in the position of the spring than the above-mentioned 0.005". Thus, if the contact member is fixed to the spring by mechanical means so that it can occupy only one position on the spring, the position of the button will be subject to a corresponding error. A solder connection between spring and contact member permits adjustment of the position of the latter to obtain accurate correspondence between electrical and mechanical centers. Moreover, the use of solder to connect the wiping pellet to the spring is necessary because of superior electrical connection compared to a simple mechanical joint, which is subject to corrosion, and generally to looseness on vibration. In order to use solder alone and get a joint which is strong enough to resist many times the force of gravity, and severe oscillation, a sufficient area of contact between the pellet and a flexible member must be provided.

However, this requirement is contradicted by the desirable shape of the spring. The tapered shape advantageously combines high deflection, and efficient use of the maximum allowable flexural strength of the spring material.

A wide straight spring would be too stiff, hence the pressure too sensitive to the vertical distance between support point and track. A narrow straight spring would be too weak or would be overstressed at the support point where stress is highest. However, a tapered spring is not big enough at the end to properly support the contact. Hence the present invention is designed to provide means to overcome this problem.

It is therefore a primary object of the present invention to provide a brush arm adapted to mount a metal pellet whereby the bond between pellet and arm can withstand a maximum thrust.

It is a further object of the present invention to provide an improved potentiometer brush arm having a high degree of flexibility consonant with structural strength.

Yet a further object of the present invention is to provide a potentiometer brush arm adapted to be miniaturized, yet retain the function of mounting a metal contact member in secure retaining relation.

These and still other objects and advantages of the present invention will be, in part, pointed out and, in part, apparent from the following description and accompanying drawings and the claims appended thereto.

In the drawings:

FIG. 1 is a plan view of a spring and contact assembly.

FIG. 2 is a side elevation of the device shown in FIG. 1 as incorporated in a potentiometer.

Referring now more particularly to the drawings, there is shown in FIG. 1 a device of the present invention characterized generally by the numeral 10.

Member 10 is shown as an elongated U-shaped flexible unit formed of a resilient conductive material such as beryllium copper. It is flattened in cross-section, this configuration providing the requisite inherent resiliency. End portion 12 is provided with apertures 14 suitable for retaining rivets or other fastening devices whereby the brush arm may be secured to an insulator brush block 15 by means of rivets 17 or similar retaining unit.

As shown in the drawing, the base of U-shaped member 10 is bent around the brush block so as to prevent rotation of the spring member. In the event that the particular potentiometer design does not permit of this U-shaped construction, then end portion 12 could be elongated to provide for additional apertures 14 so as to accommodate at least two rivets 17 in order to prevent rotation of the spring member about the single rivet. The body portion 13 of the brush arm tapers gradually towards the other extremity, forming a narrow neck portion 18. The area between neck portion 18 and end edge 20 is widened transversely to define a generally rectangular portion 16. The width of this portion is substantially equal to that of the widest portion of the brush arm, namely, at portion 12. There is thus formed an area on the brush arm adapted to retain contact 22, formed of metal alloy, such as a platinum alloy or the like. This contact member is rigidly positioned on area 16 by soldering techniques. Since area 16 has been proportioned with adequate length and width a strong retentive solder joint area can be positioned thereon.

Contact member 22 is half round, as shown in FIG. 2. Thus, the contact surface between pellet 22 and a resistance element 23 will have a high degree of resolution, as only a minimal portion of this contact will abut this coil or strip in wiping relation. The metal contact may be attached to the spring member by means of the usual soldering or welding techniques. In like fashion, body portion 13' carries contact member 22' which will traverse the takeoff member 30.

As conventionally employed, a voltage source is connected to the extremities of resistance element 23 and a voltage output circuit is connected between one of the terminals of the voltage source and takeoff 30 so that the potential applied to this output circuit will be some portion of the potential of the voltage source. The output circuit may be a voltmeter and the brush block may be connected by suitable actuating means to an apparatus whose position is being monitored so that the reading on the voltmeter would be a direct indication of the position of the member whose position is being monitored.

The minimum width of the spring at the support end 12 is limited by the physical requirements for adequate space to secure it to the brush block 15. On the other hand, the spring should be tapered for the reasons stated earlier. It has been found that if the taper lines A and B from spring deflection line D are projected to intersection point C, then the elongated portion 16 should be positioned so that the nominal center line E of the contact member intersects lines A and B at a point where the spacing of A from B is between ⅓ and ⅕ the width, W, of the spring at the deflection line D.

Contact member 22 may extend over the edges of elongated portion 16. However, it has been found desirable to extend the length, as measured along the length of the spring, of elongated portion 16 approximately 20 percent more than the length of the contact member. This increase in dimension is necessary to permit the adjusting of the contact position to mechanically coincide with the electrical output of the potentiometer.

In a typical device, there is employed a 0.020" radius, semi-cylindrical contact member having a base length of 0.040" and a width of 0.085" as measured along the axis of the member. The corresponding spring member has a length of 0.230", as measured from bend line D to line F, and an elongated end portion having a length of 0.050" and a width of 0.075". This permits positioning of the center of the contact member ±0.005" from the center of the elongated member. The contact member extends 0.005" on either side of the elongated member. Narrow neck portion 18 is provided with a small fillet, in this case of 0.010" radius.

There has thus been provided in accordance with the present invention, a brush arm combining flexibility with a structural configuration adequate to retain a wiper contact in secure, non-rupturable relation by means of a solder or weld bond. Various changes and modifications in the device of the present invention may be made by those skilled in the art without, however, departing from the spirit thereof.

What is claimed is:

1. In a rectilinear potentiometer, the combination of an elongated potentiometer element and a miniaturized brush arm and wiper contact assembly for traversing said potentiometer element in contact therewith, said brush arm and wiper contact assembly comprising a flat, resilient metal spring member, having an elongated portion terminating in a broad portion at one end adapted to be mounted upon a movable supporting structure and extending not more than one-half inch from the point of mounting upon said structure, and a wiper contact mounting portion at the other end, said member being tapered so as to form a narrow neck portion proximate to the wiper contact mounting portion, said wiper contact mounting portion having a width approximately equal to the width of said broad portion, and a metal wiper contact composed of a metal other than that of said resilient metal spring, affixed by means of solder to said wiper contact mounting portion wherein said elongated portion is aligned in the direction of normal movement of said movable supporting structure for traversing said potentiometer element.

2. In a rectilinear potentiometer, the combination of an elongated potentiometer element and a miniaturized brush arm and wiper contact assembly for traversing said potentiometer element in contact therewith, said brush arm and wiper contact assembly comprising a flat, resilient metal spring member, having an elongated portion terminating in a broad portion at one end adapted to be mounted upon a supporting structure and extending not more than one-half inch from the point of mounting upon said structure and a rectangular wiper contact mounting portion at the other end, said member being tapered so as to form a narrow neck portion proximate to the wiper contact mounting portion, said wiper contact mounting portion having a width approximately equal to the width of said broad portion and a semi-cylindrical, rectangular base, metal wiper contact composed of a metal other than that of said resilient metal spring, attached by means of solder to said wiper contact supporting portion, wherein said elongated portion is aligned in the direction of normal movement of said movable supporting structure for traversing said potentiometer element.

3. In a rectilinear potentiometer, the combination of an elongated potentiometer element and a miniaturized brush arm and wiper contact assembly for traversing said potentiometer element in contact therewith, said brush arm and wiper contact assembly comprising a flat, resilient metal spring member, having an elongated portion terminating in a broad portion at one end adapted to be mounted upon a supporting structure and extending not more than one-half inch from the point of mounting upon said structure and a wiper contact mounting portion at the other end, said member being tapered so as to form a narrow neck portion proximate to the wiper contact

mounting portion, said wiper contact mounting portion having a width approximately equal to the width of said broad portion, the tapering edges of said member being defined by a pair of intersecting lines extending the tapering edges of said member and spaced from one-third to one-fifth the width of said broad portion at the center of said wiper contact supporting portion, and a metal wiper contact, composed of a metal other than that of said resilient metal spring, affixed by means of solder to said wiper contact mounting portion, wherein said elongated

portion is aligned in the direction of normal movement of said movable supporting structure for traversing said potentiometer element.

References Cited in the file of this patent

UNITED STATES PATENTS

2,625,633 Warsher ---------- Jan. 13, 1953

FOREIGN PATENTS

122,051 Australia ---------- Aug. 19, 1946